AD-A179 607 DEVELOPMENT OF A 400 G-TON GEOTECHNICAL CENTRIFUGE(U) 1/1
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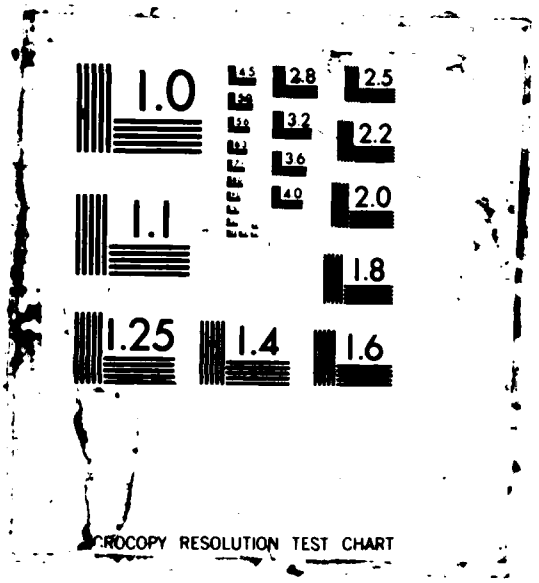
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This report summarizes the development of a large 400 g-ton centrifuge facility at the University of Colorado. The $1,800,000 facility is being funded by the University of Colorado as well as several federal agencies, including AFOSR, and industry. At the time of this report, the installation of the centrifuge is almost complete. A February, 1987 start-up date is being scheduled.

The centrifuge is capable of taking a 2-ton payload to a maximum gravity ratio of 200 g on the end of a 18 ft. arm. It has 100 electrical slip rings and 3 hydraulic rotary joints. It will be the largest geotechnical centrifuge in the world outside the Soviet Union. It will be available for research and testing by universities, government agencies and industry.

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TECHNICAL REPORT TO AFOSR

ON

Grant no. AFOSR 84-0211

Development of a 400 g-ton Geotechnical Centrifuge

by

Hon-Yim Ko

University of Colorado

The project to develop a 400 g-ton geotechnical centrifuge was first conceived in June, 1983. After receiving commitments from the University of Colorado for partial funding, a concerted effort was undertaken to solicit funding for the centrifuge equipment and the building to house it. The original estimate at that time was $700,000 for the centrifuge system and $300,000 for the building. When the proposal to solicit $200,000 from DoD under the University Research Instrumentation Program was submitted in December 1983, funding in hand consisted of $600,000 from university sources and $200,000 from the U.S Bureau of Reclamation. As a result of the grant proposal to the DOD/URIP program, a $100,000 grant was awarded in April 1984. It was then still necessary for us to raise the remaining funds to make up the estimated cost of the project.

The rest of this report documents the progress of the project to-date (November, 1986), in both the technical aspects as well as the financial conditions.

Chronological Events

In the fall of 1983, bids were invited from equipment manufacturers worldwide for the design and fabrication of a 400 g-ton geotechnical centrifuge system. From the proposals received, two firms were selected

and each awarded a $10,000 preliminary design contract. These firms were Wyle Laboratories and Contraves. In the spring of 1984, the preliminary designs and firm price quotes submitted by both firms were reviewed and Wyle Laboratories was selected for the final design and fabrication of the centrifuge system. Since by then we have already received a 900 h.p. electric motor as a donation from the General Electric Company, Wyle advised us that the drive should not be included in the contract, to be handed separately by the University of Colorado with advice from Wyle. A fixed price contract of about $600,000 was then awarded to Wyle for the centrifuge system in May 1984, with an additional estimated $140,000 to be spent on the drive, consisting of the controller, brakes, gear box and controls. A time and material consulting contract was established with Wyle to compensate it for the efforts spent in coordinating the control system acquisition. A 14-month delivery of the centrifuge was quoted by Wyle.

In the meantime, the process to select an architect to design the centrifuge building proceeded smoothly, with the architectural firm of Pahl, Pahl and Pahl being selected in February, 1984. Their design was subsequently sent out for bids in the fall of 1984, with the low bid coming in at approximately $700,000 (including architect's fees). Because this figure was considerably higher than the original estimate, it was necessary to obtain university approval before authorizing the construction to proceed. That approval was given and construction began in April 1985. The building was completed in February 1986, with total costs at about $800,000, including change orders. Because of the large electric power consumption required by the centrifuge, it was necessary to establish an electrical substation within the centrifuge building. To pay

for this added cost, the University agreed to contribute an additional $100,000 for the project, bringing all contributions from internal sources to $700,000.

In the summer of 1985, Wyle approached the University in an attempt to renegotiate its contract to deliver the centrifuge system, on the basis that it had grossly underbid the centrifuge contract. When the dust had settled in November, Wyle agreed to resume the work as called for, without any additional budget increase. The scope of the time and material contract was widened to allow for some charging of Wyle efforts that did not fall clearly within the centrifuge contract. The drive and control system was designed by Wyle, consisting of the gear box, brakes and a controller from Industrial Electric Company at $140,000 and the control panels with software from Klockner-Moeller at $85,000. The drive controller was delivered and checked out in May, 1986 and the control panels were delivered and checked out in October 1986.

In June 1986, we requested Wyle to make a modification to the end of the centrifuge arm in order to maximize the volume of the payload package that can be mounted for testing. This caused a delay of 3 months and a cost increase of $30,000.

As of November 10, 1986, there are two remaining items to be delivered by Wyle to the University. The electric slip ring and hydraulic rotary joint package is scheduled for delivery toward the end of November. Assembly of the rotar arm is being completed in Birmingham, Alabama for shipping in early December. When all components have arrived at the University of Colorado, hook-up to the control system will be

made. We anticipate that 6 to 8 weeks will be required for the check-out, leading to an estimated start-up date of February 1, 1987.

Centrifuge System

A schematic of the 400 g-ton centrifuge is shown in Fig. 1. The centrifuge can carry a 2-ton payload to 200g on a swing platform at the end of a 18 ft. radius rotor arm. The maximum payload size will be 4 ft. x 4 ft. x 3 ft. The centrifuge is driven by a 900 h.p. electric D.C. motor, through a right angle gear box with a 10 to 1 speed reduction. Four pneumatically operated disk brakes are mounted in line with the motor.

The centrifuge is balanced by mounting deadweights on the end opposite to the payload. Inflight adjustment of any imbalance can be made by moving water contained in tanks inside the rotor arm structure. The imbalance is sensed by strain-sert bolts connecting the water tanks to the central bulkhead of the centrifuge. Mounted above the bulkhead is the package containing 100 electrical slip rings and 3 hydraulic rotary joints.

The chamber in which the centrifuge rotates is 42 ft. in diameter. Cooling tubes are embedded in the chamber wall to remove the heat generated by friction between the wall and the cylindrical air mass being pushed around by the rotating centrifuge. This feature was deemed necessary after reviewing the overheating problems encountered in other geotechnical centrifuges.

The centrifuge chamber is located below ground for obvious safety reasons. The two-story building above the centrifuge pit consists of 4000 sq. ft of floor space dedicated to this facility, which will house the

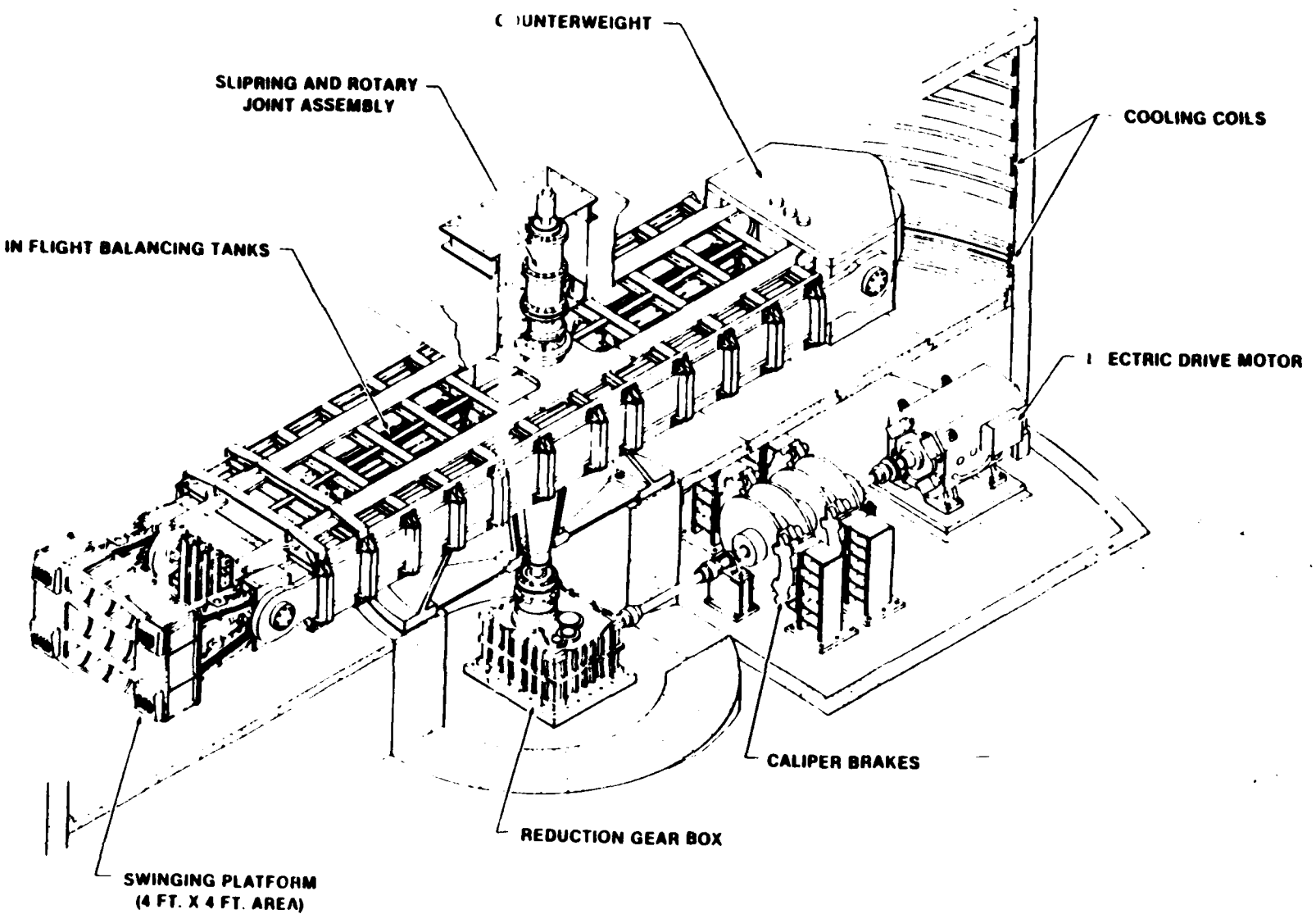

FIG. 1. UNIVERSITY OF COLORADO 400 G-TON CENTRIFUGE

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